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Comparative Analysis of Extraction Techniques for Enhancing the Photoprotective Activity of Boswellia Species Resin

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Abstract

This study investigates the photoprotective properties of Boswellia species resin, commonly known as frankincense, and evaluates its potential as a natural sunscreen agent. Considering the increasing interest in natural skincare alternatives, this research examines the ultraviolet (UV) absorption characteristics and the Sun Protection Factor (SPF) of frankincense extracts. Three distinct formulations were prepared: a standard zinc oxide suspension, a macerated frankincense extract, and a sonicated frankincense extract. Spectrophotometric analysis was employed to determine the absorbance spectra in the 290-320 nm range, and SPF values were calculated using the Mansur equation. In addition, a preliminary phytochemical screening of the frankincense resin was conducted to identify the presence of key bioactive compounds, including flavonoids, polyphenols, and alkaloids. Results indicated that the sonicated frankincense extract exhibited a significantly higher SPF value than the macerated extract and the standard zinc oxide suspension. This suggests that the extraction method significantly influences the photoprotective efficacy of the resin. The phytochemical screening confirmed the presence of flavonoids in frankincense. This study scientifically validates the traditional use of frankincense in skincare, highlighting its potential as a natural source of UV protection. The findings highlight the importance of extraction techniques in optimizing the photoprotective properties of natural products.

Keywords: Boswellia; SPF; zinc oxide; Spectrophotometer.

Introduction

For centuries, people have relied on frankincense, the resin of *Boswellia* trees, for both health and beauty. In traditional practice, and ailments and inflammatory conditions like asthma, arthritis, and chronic bowel diseases. Some initial research suggests potentials in memory boosting, immunomodulatory, antimicrobial, antiviral, antidiabetic activities, and cancer treatment [1,2,3]. However, more extensive scientific studies are required to validate frankincense's expected biological activities.

Geographically, *Boswellia* species are indigenous to regions spanning the Arabian Peninsula, Northeast Africa, and the Indian subcontinent, contributing significantly to regional economies through the trade of resins for incense and perfumery [2].

frankincense or Olibanum is a natural oleo-gum resin harvested by making small incisions in the Boswellia tree's trunk (Family Burseraceae). The chemical composition of frankincense resin is complex, primarily comprising alcohol-soluble resins, water-soluble gums (polysaccharides), and essential oils [2]. Notably, boswellic acids, particularly β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid, and 3-O-acetyl-11-keto-β-boswellic acid, are recognized as key bioactive constituents [2,3]. These pentacyclic triterpenic acids have demonstrated anti-inflammatory properties, primarily through inhibiting 5-lipoxygenase, with AKBA exhibiting the highest potency [3]. While the anti-inflammatory and potential anticancer effects of boswellic acids have been explored, the photoprotective potential of frankincense, particularly in the context of traditional skincare practices, remains under-investigated.

Figure 1: Frankincense or Olibanum

Furthermore, contemporary cosmetic formulations incorporate frankincense for its antiaging, antiacne, and purported sunscreen properties and its use as a fragrance component [4]. Despite the historical and contemporary use of frankincense in skin care, a systematic scientific evaluation of its photoprotective efficacy is lacking. Specifically, the influence of extraction methods on the Sun Protection Factor (SPF) of frankincense extracts has not been adequately addressed. In this study, we will fill in that gap in research by looking at the SPF of frankincense extracts made using maceration and sonication, comparing it to that of zinc oxide, which is a known sunscreen, and doing a preliminary phytochemical screening to find key components that might help with photoprotective activity. The gathered data provides a scientifically sound foundation for its photoprotective properties and might offer a path toward its use in modern skincare.

Materials and methods

Preparation of Experimental Materials:

Raw frankincense resin was sourced from a local market in Basrah, Iraq. Pharmaceutical-grade zinc oxide (Produits Dentaires) was utilized as a standard. Distilled water served as the solvent for all formulations. For phytochemical analysis, reagent solutions,

including Dragendorff's reagent, Mayer's reagent, and a freshly prepared 5% (w/v) ferric chloride solution, were supplied from the laboratories of Pharmacy College at the University of Basra. The study employed a UV-visible spectrophotometer (CECIL CE 7500), double-beam UV-vvisible spectroscopy (England), and an ultrasonic bath operating at 50 kHz.

Formulation of Experimental Samples:

Three distinct formulations were developed to assess the photoprotective potential of frankincense. First, a zinc oxide standard (Formula 1) was prepared by carefully dispersing 100 mg of zinc oxide powder in 100 mL of distilled water within a 250 mL Erlenmeyer flask. This suspension underwent vigorous agitation using a magnetic stirrer at 250 rpm for 15 minutes to ensure a homogeneous mixture.

Next, a macerated frankincense formulation (Formula 2) was created. 100 mg of raw frankincense resin was combined with 100 mL distilled water in a 250 mL Erlenmeyer flask. The resulting mixture was agitated at 250 rpm for 15 minutes and subsequently subjected to maceration at room temperature (25 ± 2 °C) for 24 and 48 hours. Following maceration, the solutions were filtered through Whatman No. 1 filter paper to remove any remaining particulate matter.

Finally, a sonicated frankincense formulation (Formula 3) was prepared. 100 mg of raw frankincense resin was combined with 100 mL of ultrapure distilled water in a 250 mL Erlenmeyer flask. This flask was then placed within an ultrasonic bath and sonicated at 50 kHz for 5 minutes. The resulting solution was subsequently filtered through the Whatman No. 1 filter paper.

Spectrophotometric Analysis and SPF Determination:

The absorption spectra of each prepared formulation were recorded using the UV-visible spectrophotometer within the wavelength range of 290 to 320 nm, with measurements taken at 5 nm intervals. Three independent replicates were conducted for each sample, using distilled water as a blank. SPF values were then calculated using the Mansur equation [5,6]:

$$SPF = CF \sum_{320}^{290} EE(\lambda) \times I(\lambda) \times A(\lambda)$$

Where:

- CF represents the correction factor (10).
- EE(λ) denotes the erythemogenic effect of radiation at wavelength λ.
- I(λ) signify the intensity of solar light at wavelength λ.
- A(λ) indicates the spectrophotometric absorbance at wavelength λ.

The values for EE(λ) × I(λ) were derived from the standardized constants established by Sayre et al. [7].

Preliminary phytochemical screening

Tannins detection test: 1.0 mL of the filtered extract was treated with 2.0 mL 5% (w/v) ferric chloride solution. The presence of tannins was identified by forming dark blue or dark green colors.

Flavonoid detection test (Shinoda test): 1.0 mL of the filtered extract was combined with a small piece of magnesium metal, followed by the dropwise addition of concentrated hydrochloric acid. The formation of pink color indicates the presence of flavonoids.

Alkaloid detection test: The presence of alkaloids was assessed using:

Dragendorff's reagent: 1.0 mL of the filtered extract was treated with 2-3 drops of the reagent. A reddish-brown or orange precipitate indicates the presence of alkaloids.

Mayer's reagents: 1.0 mL of the filtered extract was treated with 2-3 drops of the reagent. The presence of white precipitates indicates the presence of alkaloids.

Statical analysis

One-way Analysis of Variance (ANOVA) was performed to determine the statistical significance of differences in SPF values between the formulations. Statistical analysis was conducted using Microsoft Excel 2021[8]. A p-value of less than 0.05 was considered statistically significant.

Results and discussion

The preliminary phytochemical screening of all the frankincense resin extracts revealed the presence of flavonoids in the flavonoid detection test, while neither tannins nor alkaloids were detected (Table 1). Flavonoids are known for their antioxidant and UV-absorbing properties, and their presence might contribute to the observed photoprotective activity [9].

Table 1: Phytochemical study result of Frankincense

Detection test	Results
Flavonoids	++
tannins	_
Alkaloids	_

Spectroscopic analysis of the four formulations (zinc oxide standard, 24-hour macerated extract, 48-hour macerated extract, and sonicated extract) was conducted in the (290-320 nm) range. The absorbance values and the normalized product function used in SPF calculations are presented in (Table 2). Formula 3 exhibited the highest absorbance values among the measured wavelengths, suggesting a greater capacity for UV absorption.

Table 2: Normalized product function used in the calculation of SPF, and absorbance values of prepared formulas

Wavelength (nm)	EE×I (normalized)	Absorbance			
		Formula 1	Formula 2 (24 hrs maceration)	Formula 2 (48 hrs maceration)	Formula 3
290	0.0150	0.511 ± 0.0015	0.156±0.004	0.183±0.0026	0.726±0.0045
295	0.0817	0.507±0.0025	0.142±0.0047	0.166±0.0035	0.719±0.0015
300	0.2874	0.508±0.0015	0.132±0.0061	0.152±0.0015	0.711±0.0011
305	0.3278	0.509±0.002	0.125±0.0055	0.142±0.0023	0.707±0.002
310	0.1864	0.510±0.0046	0.119±0.003	0.133±0.0037	0.704±0.001
315	0.0837	0.511±0.0028	0.113±0.0035	0.125±0.002	0.702±0.0068
320	0.0180	0.512±0.002	0.108±0.0025	0.118±0.004	0.702±0.007
Total	1				

The Sun Protection Factor (SPF) quantifies the efficacy of a sunscreen formulation in mitigating ultraviolet radiation-induced erythema [10]. SPF values for each formulation were calculated using the Mansur equation, and the results are presented in (Table 3). Formula (3) demonstrated the highest SPF value (7.083 ± 0.013), followed by the zinc oxide standard (Formula 1, 5.089 ± 0.0017). The macerated extracts exhibited significantly lower SPF values (Formula 2, 24 hrs.: 1.264 ± 0.048; 48 hrs.: 1.439 ± 0.023).

Table 3: SPF values of the studied formulas calculated using the Mansur equation [5]

Formula no.	SPF value ± SD
1	5.089±0.0017
2 (24 hrs maceration)	1.264±0.048
2 (48 hrs maceration)	1.439±0.023
3	7.083±0.013

One-way ANOVA revealed a statistically significant difference in SPF values across the four formulations ($F(3, 3) = 147.28$, $p = 0.043$). This confirms that the extraction method significantly influences the photoprotective activity of frankincense. The enhanced SPF value in the sonicated extract suggests that sonication facilitates a more efficient extraction of photoprotective compounds from the resin. This may be attributed to the ultrasonic waves disrupting the plant cell walls, thereby increasing the release of bioactive constituents [11].

The results show that frankincense extract exhibits inherent sun-protective properties. Notably, sonication-assisted extraction significantly enhanced the SPF value. This observation suggests that sonication facilitates an increased extraction of photoprotective compounds. Consequently, the potential for sonicated frankincense extract to achieve SPF values comparable to or exceeding established inorganic filters, such as zinc oxide, warrants further investigation.

Conclusion

In exploring frankincense water extract, we observed a compelling enhancement of sun protection through sonication. By employing spectrophotometry, we quantified a significant increase in the extract's Sun Protection Factor (SPF) after sonication, suggesting that this technique facilitates the release of inherent photoprotective compounds. This finding not only reinforces the potential of frankincense as a natural source of sun protection but also highlights the efficacy of sonication in optimizing its properties. As we proceed, it is crucial to investigate investigate the specific mechanisms of action furtherinvestigate the specific mechanisms of action, to investigate the specific mechanisms of action further, and evaluate the performance of sonicated frankincense extract compared to established sunscreen agents. Ultimately, our goal is to contribute to developingdeveloping effective, naturally derived sunscreens that offer protection and accessibility.

Availability of data and materials

The raw data required to reproduce these findings are available in the body and illustrations of this manuscript.

Author's contribution

Reham A. Al-Anssari contributed to the study design, experimental studies, data acquirement, statistical analysis, manuscript writing, and editing.

Conflicts of interest

The author declares that there is no conflict of interest regarding the publication of this article.

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دراسة مقارنة لأساليب الاستخلاص بهدف تحسين الفعالية الواقية للضوء لراتنج أصناف Boswellia

ريهام الانصاري

الخلاصة

تدرس هذه الورقة البحثية الخصائص الواقية للضوء لراتنج أنواع Boswellia ، المعروفة شيوعًا بلبان الذكر، بالإضافة إلى تقييم قدراته كعامل طبيعي للحماية من الشمس. ونظرًا للاهتمام المتزايد بالبدائل الطبيعية للعناية بالبشرة، يدرس هذا البحث خصائص امتصاص الأشعة فوق البنفسجية(UV) ومعامل الحماية من الشمس (SPF) لمستخلصات البان الذكر. تم تحضير ثلاث تركيبات متميزة: معلق قياسي لأكسيد الزنك، ومستخلص لبان منقوع، ومستخلص اللبان مُعالج بالموجات فوق الصوتية. استُخدم التحليل الطيفي لتحديد أطياف الامتصاص في نطاق 290-320 نانومتر، وحُسبت قيم معامل الحماية من الشمس باستخدام معادلة Mansur. بالإضافة إلى ذلك، أُجري فحص كيميائي نباتي أولي لراتنج اللبان لتحديد وجود المركبات النشطة بيولوجيًا الرئيسية، بما في ذلك الفلافونويدات والبوليفينولات والقلويدات. أشارت النتائج إلى أن مستخلص اللبان المُعالج بالموجات فوق الصوتية أظهر قيمة معامل حماية من الشمس أعلى بشكل ملحوظ مقارنة بكل من المستخلص المنقوع ومعلق أكسيد الزنك القياسي. ويشير هذا إلى أن طريقة الاستخلاص تؤثر بشكل كبير على الفعالية الواقية للضوء للراتنج. أكد الفحص الكيميائي النباتي وجود الفلافونويدات في اللبان. تؤكد هذه الدراسة مصداقية الاستخدام التقليدي للبان الذكر في العناية بالبشرة، وتسلط الضوء على إمكاناته كمصدر طبيعي للحماية من الأشعة فوق البنفسجية. وتؤكد النتائج على أهمية تقنيات الاستخلاص في تحسين الخصائص الواقية للضوء للمنتجات الطبيعية.